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## ORIGINAL ARTICLE

# The First Ever External Quality Assessment Program on Urinary Sediment in a Country of Sub-Saharan Africa Based on New Smartphone Technologies

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[*] ***Joseph E. Endayake, who had an important role in the inception and development of this article, died on July 11, 2019. This paper is dedicated to his memory***

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## SUMMARY

***Background:*** **External Quality Assessment (EQA) programs on urinary sediment (U-sed) examination are recommended by international guidelines to improve the quality of this diagnostic tool. However, no such programs have been carried out so far in developing countries of sub-Saharan Africa. This paper describes an EQA program on U-sed which was realized in 2017 and 2018 by means of innovative communication technologies in Benin Republic, a small country of West Africa.**

***Methods:*** **On Monday morning, weekly in 2017 and fortnightly in 2018, the image of one U-sed element was sent from Italy with a smartphone, via WhatsApp application, to a group of 13 professionals (11 bachelors of science, 2 medical doctors) working in different institutions of Benin Republic. The image showed one U-sed element, for which the participants were asked the identification and, in 2018, also a clinical association.**

***Results:*** **The images of 33 elements were submitted over the two-year period. *Particle identification.* Altogether 283 answers were received (8.5 ± 2.3/single image), 200 of which were correct (70.7%), 53 incorrect (18.7%), 17 partially correct (6.0%), and 13 "I don't know" (4.6%). *Correct identification of elements presented twice* (2nd answer vs. 1st). No change: 9/18 (50.0%); improvement: 5/18 (27.8%); worsening: 4/18 (22.2%). *Clinical association.* Correct answers: 8/17 (47%); incorrect: 8/17 (47.0%); no answer: 1/17 (5.6%).**

***Conclusions:*** **This paper demonstrates: 1. The need and utility of an EQA program on U-sed in developing countries of sub-Saharan Africa; 2. The feasibility of such programs by means of easily available and inexpensive smartphone applications.**


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## KEY WORDS

urinalysis, urinary sediment, external quality assessment program, smartphone technology, WhatsApp application


## INTRODUCTION

The examination of urinary sediment (U-Sed) is an important tool for the diagnosis of the diseases of the kidneys and urinary tract [1-4]. In the developed world various external quality assessment (EQA) programs on U-

sed are carried out in order to improve the accuracy of this diagnostic test, both at the national [5,6] and international level [7,8]. However, to the best of our knowledge, no such programs had been realized so far in developing countries of sub-Saharan Africa.
In this paper we describe a small but innovative EQA program on U-sed based on the use of smartphone communication technology, which has been carried for two years (2017 - 2018) in Benin Republic, a sub-Saharan country of West Africa.

## MATERIALS AND METHODS

The EQA program started in January 2017 as part of a long-lasting voluntary-based cooperation, the first years of which have been described elsewhere [9,10], between one of us (G.B.F.) and Saint Jean de Dieu hospital, a Hospitaller Order institution, which belongs to the Benin national healthcare system and is located in Tanguiéta, a town of the Atakora Department in the North-west region of the country.

### Benin

It is a developing sub-Saharan country of West Africa, which until the 1st of August 1960 was a French colony belonging to French West Africa under the name of Dahomey. It lies between Nigeria in the East, Togo in the West, Burkina Faso, and Niger in the North, and the gulf of Guinea in the South. It has a surface of 114,763 $km^2$, a population of almost eleven million inhabitants, and poor demographical, social, and healthcare indicators, as shown in Table 1 [11].

### The EQA Program

#### Aim

To improve the identification skill of the U-sed elements and the knowledge of their clinical meaning in the clinical laboratories of a country in which the diagnostic power for renal and urinary tract diseases is very limited and renal biopsy is not available.

#### Recipients

The EQA program was addressed to laboratory professionals who had attended practical and theoretical courses on U-sed, either basic (five days) or basic + advanced (five + three days), which had been organized and run by three of us (G.B.F., J.E.E., and B.S.) at Saint Jean de Dieu hospital in November in 2016 and 2017, respectively.

#### Program

On Monday, weekly in 2017 and fortnightly in 2018 (with some pauses during holiday periods), G.B.F. sent the image of one element of the U-Sed from Italy through his smartphone using WhatsApp (WA) application. The receivers were the members of the WA group “Sédiment Urinaire Afrique (SUA)”, which included the participants in the courses mentioned above. The image was selected from the U-sed archive of Clinical and Research Laboratory on Urinary Sediment of Ospedale Maggiore Policlinico, Milano, Italy, which is managed by one of us (G.G.). Each selected image was transferred to G.B.F. smartphone and then sent to the WA group. Each image showed one element as seen with bright field microscopy. For all elements, the original microscopic magnification was reported; for cells the major diameter in µm was added (Figure 1, left) and, for crystals, the urine pH plus one additional inset image of the same element under polarized light (Figure 1, right; Figure 2, left). In case the crystal was not birefringent, the inset stated: “No birefringence at polarized light”. Also fatty elements were shown by both bright field and polarized light images and were always associated with the statement “Dipstick for albumin positive +++”. The program also included the submission of images of repeated elements to verify whether over time there had been an improvement in their identification. After receiving the image, each participant was asked to send her/his identification of the element through her/ his smartphone to the personal mobile number of G.B.F., outside the SUA group. At the end of the week (2017) or of the fortnight (2018) on Saturday, the latter sent a comment to the SUA group containing: 1. The correct identification of the element; 2. The morphological features which enabled both its correct identification and the differentiation from other elements erroneously identified by participants; 3. Its clinical meaning; 4. The number of identifications received. These were classified as: “correct”, “partially correct” (when the element was not fully defined, e.g., calcium oxalate crystal without specifying whether it was mono- or bi-hydrated, or erythrocytes without saying whether they were isomorphic or dysmorphic), “incorrect”, “I don’t know”.
Since March 13th, 2017, the comment was always followed by “supplementary images”, which were sent to the SUA group by one of us (S.Z.). These were chosen from the image archive mentioned above and showed other images of the element of the exercise as seen with bright field or phase contrast with/without polarized light (Figure 2, right). This contribution was aimed at expanding the gallery of images and, in the end, improving the identification skill of participants.
In 2018, besides identification, for each element a clinical association was requested, which the participants had to choose among three proposed by G.B.F (Figure 3). Based on the overall limited knowledge about renal and urinary tract diseases among the participants, the clinical associations proposed were always of basic level.
The whole program was carried out in French, which is the official language of Benin Republic.

### Statistical analysis

Descriptive statistical data were presented as number, percentage, mean value ± standard deviation, and medi-

**Table 1. Some demographic and healthcare indicators of Benin Republic [11].**

| Indicator | |
|---|---|
| Total population (2016) | 10,872,000 |
| Gross national income per capita (PPP $ USA, 2013) | 1,780 |
| Life expectancy at birth m/f (years, 2016) | 60/62 |
| Probability of dying under five years (per 1,000 live births, 2018) | 93 |
| Probability of dying between 15 and 60 years old, m/f (per 1,000 population, 2016) | 265/220 |
| Total expenditure on health per capita ($ USA, 2014) | 86 |
| Total expenditure on health as % of GDP (2014) | 4.6 |

an. Due to the small number of participants and answers reported in the paper, calculations for the evaluation of statistical significance were not made.

## RESULTS

In 2017, from January 9th through September 25th, 35 images were sent to the SUA group, which showed 22 elements, 13 of which (59.1%) were presented twice, 3 to 7 months after the first submission, by means of new similar images.
In 2018, from January 15th through October 1st, 17 images were sent, 6 of which (35.3%) were of repeated elements, which had been sent for the first time in 2017, 6 to 11 months before.
Thus globally, the elements submitted for identification were 33 (Table 2): 14 were presented only one time (42.4%), 18 twice (54.6%) and 1 (3.0%) (deep transitional cells) three times (Table 3). The elements with the additional request of a clinical association were 17 (51.5%) (Table 4). The “supplementary images” were 64 (24 by bright field microscopy, 17 by phase contrast microscopy, 23 by the two techniques with/without polarized light).
In 2017, the SUA group included 13 members (2 female, 11 male; age 24 - 54 year, mean ± SD: 34.3 ± 8.7, median 32), 11 of whom are bachelors of science (BSc) (84.6%) working in clinical laboratories, and 2 (15.4%) are medical doctors (one a general practitioner and one a nephrologist), from 10 different institutions, 8 of which are located in the northern Departments of the country. In 2018, one BSc abandoned the SUA group due to a radical change in his professional life.
For the 35 exercises of 2017, the rate of participation was 56.0% ± 23.0% (median: 54%, range: 17.1% - 85.7%); for the 17 exercises of 2018 the rate increased to 77.0% ± 16.5% (median: 79%, range: 47.1% - 100%).

### Element identification when presented for the 1st time (Table 2)

For the 33 exercises, 283 answers were received, which means 4 - 13 answers (8.5 ± 2.4, median: 9)/single element. Two-hundred answers were correct (70.7%), 17 were partially correct (6.0%), 53 incorrect (18.7%), and 13 “I don’t know” (4.6%). The correct answers were: 100% for 8 elements out of 33 (24.2%) (leukocytes, superficial transitional epithelial cells, squamous epithelial cells, fatty cast, crystals of uric acid, triple phosphate, calcium phosphate, and egg of *Schistosoma haematobium*); 80.0% to 99.0% for other 7 elements (21.2%); 50.0% to 79.0% for 13 (39.4%); < 50.0% for 5 elements (15.2%) (deep transitional epithelial cells, cholesterol crystals, epithelial cast, calcium phosphate plate, and ammonium biurate crystals).

### Identification of elements presented twice (Table 3)

Only the answers of participants who replied both to the 1st and the 2nd presentations were considered. The rate of correct + partially correct answers for 9 elements out of 18 (50.0%) did not change between the first and the 2nd answer (8: 100%; 1: 62.5%); for 5 elements (27.8%) the mean rate increased from 64.2% ± 19.0% (median: 66.7%, range: 33.3% - 83.3%) to 100%; for other 4 elements (22.2%) the mean rate decreased, from 100% to 47.5% ± 27.2% (median: 42.5%, range: 25.0% - 80.0%).

### Clinical associations (Table 4)

Only the answers from the participants who had identified correctly the element were included in this evaluation. A 100% correct answer was obtained for 8 out of 17 elements (47.0%), for other 8 (47.0%) the correct answer ranged from 50.0% to 90.9% (79.7% ± 14.0%, median: 85%), while for 1 element (ammonium biurate crystal) (5.9%), which was identified correctly by only 1 participant out of 7 (14.2%), no clinical association was supplied.

## DISCUSSION

Together with internal quality control programs, EQA programs on U-sed are recommended by international guidelines on urinalysis [12,13]. However, while in the developed world various programs of this kind are currently carried out with success both at the national [5,6] and international level [7,8], no such programs exist in developing countries of sub-Saharan Africa.
In this paper we describe the first EQA program on U-sed which has been developed for sub-Saharan Africa so far. The program, which was carried out in 2017 and 2018 in Benin Republic - a small country of West Africa - was based on humanitarian cooperation and the use of modern technological communication tools. These consisted in smartphones equipped with WA application, which allowed at the same time an easy and quick transfer from Europe to Africa of high quality images of

**Table 2. The elements presented during the two-year program (here organized by category), and the identification rates when they were presented for the first time.**

| Urinary sediment element | Number of answers | Answers | | | |
|---|---|---|---|---|---|
| | | Correct | Partialliy correct | Incorrect | I don't know |
| | | n (%) | n (%) | n (%) | n (%) |
| **Cells (n = 9)** | | | | | |
| Isomorphic erythrocytes | 8 | 5 (62.5) | 3 (37.5) | 0 (0.0) | 0 (0.0) |
| Dysmorphic erythrocytes | 10 | 7 (70.0) | 2 (20.0) | 1 (10.0) | 0 (0.0) |
| Acanthocytes | 12 | 9 (75.0) | 3 (25.0) | 0 (0.0) | 0 (0.0) |
| Leukocytes | 10 | 10 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Renal tubular epithelial cells | 7 | 4 (57.1) | 0 (0.0) | 3 (42.9) | 0 (0.0) |
| Deep transitional epithelial cells | 7 | 2 (28.6) | 0 (0.0) | 5 (71.4) | 0 (0.0) |
| Superficial transitional epithelial cells | 7 | 7 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Squamous epithelial cells | 11 | 11 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Atypical transitional epithelial cells | 7 | 6 (85.7) | 0 (0.0) | 1 (14.3) | 0 (0.0) |
| **Lipids (n = 4)** | | | | | |
| Lipid droplets | 10 | 8 (80.0) | 0 (0.0) | 2 (20.0) | 0 (0.0) |
| Oval fat body | 10 | 6 (60.0) | 3 (30.0) | 0 (0.0) | 1 (10.0) |
| Fatty cast | 9 | 9 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Cholesterol crystal | 5 | 3 (30.0) | 0 (0.0) | 1 (20.0) | 1 (20.0) |
| **Casts (n = 8)** | | | | | |
| Hyaline | 10 | 8 (80.0) | 1 (10.0) | 1 (10.0) | 0 (0.0) |
| Hyaline-granular | 11 | 6 (54.5) | 0 (0.0) | 5 (45.5) | 0 (0.0) |
| Granular | 9 | 6 (66.7) | 0 (0.0) | 0 (0.0) | 3 (33.3) |
| Waxy | 11 | 7 (63.6) | 0 (0.0) | 2 (18.2) | 2 (18.2) |
| Erythrocytic | 7 | 4 (57.1) | 1 (14.3) | 1 (14.3) | 1 (14.3) |
| Epithelial * | 13 | 6 (46.2) | 1 (7.7) | 6 (46.2) | 0 (0.0) |
| Bilirubin | 7 | 6 (85.7) | 0 (0.0) | 1 (14.3) | 0 (0.0) |
| Crystalline ** | 6 | 4 (66.7) | 0 (0.0) | 2 (33.3) | 0 (0.0) |
| **Crystals (n = 9)** | | | | | |
| Uric acid | 5 | 5 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Monohydrate calcium oxalate | 7 | 6 (85.7) | 1 (14.3) | 0 (0.0) | 0 (0.0) |
| Dihydrate calcium oxalate | 7 | 5 (71.4) | 2 (28.6) | 0 (0.0) | 0 (0.0) |
| Triple phosphate | 7 | 7 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Calcium phosphate | 4 | 4 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| Calcium phosphate plate | 10 | 1 (10.0) | 0 (0.0) | 8 (80.0) | 1 (10.0) |
| Amorphous urates | 5 | 4 (80.0) | 0 (0.0) | 1 (20.0) | 0 (0.0) |
| Ammonium biurate | 7 | 1 (14.3) | 0 (0.0) | 4 (57.1) | 2 (28.6) |
| Cystine | 12 | 7 (58.3) | 0 (0.0) | 5 (41.7) | 0 (0.0) |
| **Micro-organisms (n = 2)** | | | | | |
| *Candida* | 10 | 8 (80.0) | 0 (0.0) | 1 (10.0) | 1 (10.0) |
| Egg of *Schistosoma haematobium* | 11 | 11 (100.0) | 0 (0.0) | 0 (0.0) | 0 (0.0) |
| **Contaminants (n = 1)** | | | | | |
| Starch | 11 | 7(63.6) | 0 (0.0) | 3 (27.3) | 1 (9.1) |

*** - Cast containing renal tubular epithelial cells, ** - Cast containing monohydrate calcium oxalate crystals.**

**Table 3. Elements presented twice.**

| Element | n of answers | Correct + partially correct answers | |
|---|---|---|---|
| | | 1st presentation n (%) | 2nd presentation n (%) |
| **Cells (n = 8)** | | | |
| Isomorphic erythrocytes | 5 | 5 (100.0) | 5 (100.0) |
| Dysmorphic erythrocytes | 6 | 5 (83.3) | 6 (100.0) |
| Acanthocytes | 6 | 6 (100.0) | 6 (100.0) |
| Leukocytes | 5 | 5 (100.0) | 5 (100.0) |
| Renal tubular epithelial cells | 3 | 2 (66.7) | 3 (100.0) |
| Deep transitional epithelial cells * | 3 | 1 (33.3) | 3 (100.0) |
| Superficial transitional epithelial cells | 4 | 4 (100.0) | 1 (25.0) |
| Squamous epithelial cells | 7 | 7 (100.0) | 7 (100.0) |
| **Lipids (n = 2)** | | | |
| Droplets | 8 | 6 (75.0) | 8 (100.0) |
| Fatty cast | 5 | 5 (100.0) | 5 (100.0) |
| **Casts (n = 5)** | | | |
| Hyaline | 4 | 4 (100.0) | 4 (100.0) |
| Granular | 2 | 2 (100.0) | 2 (100.0) |
| Waxy | 8 | 5 (62.5) | 8 (100.0) |
| Erythrocytic | 5 | 5 (100.0) | 4 (80.0) |
| Epithelial ** | 8 | 5 (62.5) | 5 (62.5) |
| **Crystals (n = 3)** | | | |
| Uric acid | 4 | 4 (100.0) | 1 (25.0) |
| Monohydrate calcium oxalate | 5 | 5 (100.0) | 3 (60.0) |
| Dihydrate calcium oxalate | 6 | 6 (100.0) | 6 (100.0) |

*** - These cells were submitted a 3rd time: 2 answers were obtained, both correct, ** - Cast containing renal tubular epithelial cells.**

U-sed elements and an intensive intercourse with a structured group of laboratory professionals involved in U-sed examination. These new technologies are today largely used all over the world and, together with other recent advancements [14,15], can be used to introduce educational programs aimed at improving the quality of laboratory medicine, which in developing countries is still facing many and major difficulties and limitations [16].

Our EQA program on U-sed was aimed at improving the identification skill for U-sed elements and the knowledge of their clinical meaning, in a context in which the diagnostic tools for the diagnosis of urinary tract diseases are very limited, and the potential value of U-sed examination is almost totally unrecognized, in favor of the use of dipstick alone. For this reason, we developed an intensive program which, for the first year included the presentation of the image of one U-sed element per week and, the subsequent year, every two weeks. In this way we were able to present in a short period of time a high number of elements, some common and others rare but clinically relevant, such as cystine crystals and crystalline casts. In addition, a number of such elements were presented twice by means of similar images, in order to evaluate whether over time there was an improvement in the identification skill. Early in the program, we also introduced supplementary images aimed at broadening the knowledge of the morphological spectrum which each U-sed element may display. The images of the particles presented had all been obtained by bright field microscopy coupled, for crystals and lipids, with polarized light. Bright field microscopy was chosen because in only three institutions out of ten involved in our program phase contrast microscopy was - and still is - available, as it is for polarized light. In the second year of the program, we also asked the participants to choose a clinical association among three proposed, which was aimed at improving the quality of interpretation of U-sed examination results [17].

Our innovative program had only 13 participants, which makes its results not comparable with those found in other current EQA programs on U-sed, which are carried out in the developed world and include hundreds [5, 7] or even thousands of participants [8]. Our small number of participants is due to the fact that our program was the first ever developed in a sub-Saharan country and the participants represented a selected group of clinical biologists.

**Table 4. Results of clinical associations from the highest to the lowest rate of correct answers.**

| Element | Number * | Correct clinical association | Correct n (%) | Incorrect n (%) | No answer n (%) |
|---|---|---|---|---|---|
| Lipid droplets | 12/12 | Glomerulonephritis | 12 (100.0) | 0 (0.0) | 0 (0.0) |
| Egg of *Schistosoma haematobium* | 11/11 | Infection of the urinary system due to a parasite | 11 (100.0) | 0 (0.0) | 0 (0.0) |
| *Candida* | 8/10 | Urine contamination from genital secretions | 8 (100.0) | 0 (0.0) | 0 (0.0) |
| Deep transitional epithelial cells | 7/8 | Urological disease | 7 (100.0) | 0 (0.0) | 0 (0.0) |
| Atypical transitional epithelial cells | 6/7 | Bladder cancer | 6 (100.0) | 0 (0.0) | 0 (0.0) |
| Epithelial cast ** | 6/10 | Severe kidney disease | 6 (100.0) | 0 (0.0) | 0 (0.0) |
| Crystalline cast *** | 4/6 | High concentration of oxalate in urine | 4 (100.0) | 0 (0.0) | 0 (0.0) |
| Calcium phosphate plate | 1/10 | If persistent in repeated samples: possible/likely urinary stones | 1 (100.0) | 0 (0.0) | 0 (0.0) |
| Squamous epithelial cells | 11/11 | Urine contamination from genital secretions | 10 (90.9) | 0 (0.0) | 1 (9.1) |
| Erythrocytic cast | 11/12 | Hematuria of renal origin | 10 (90.9) | 1 (9.1) | 0 (0.0) |
| Waxy cast | 10/10 | Severe kidney disease | 9 (90.0) | 1 (10.0) | 0 (0.0) |
| Starch | 7/11 | Urine contamination | 6 (85.7) | 1 (14.3) | 0 (0.0) |
| Bilirubinic cast | 6/7 | Severe liver disease | 5 (83.3) | 1 (16.7) | 0 (0.0) |
| Amorphous urates | 4/5 | High concentration of uric acid in urine (either transient or persistent) | 3 (75.0) | 1 (25.0) | 0 (0.0) |
| Cystine crystals | 7/12 | Hereditary kidney disease | 5 (71.4) | 2 (28.6) | 0 (0.0) |
| Hyaline-granular cast | 6/11 | Renal disease if in association with pathological casts | 3 (50.0) | 3 (50.0) | 0 (0.0) |
| Ammonium biurate crystals | 1/7 | Delayed urine examination | 0 (0.0) | 0 (0.0) | 1 (100) |

*** - Number of participants with access to the association/total number of participants, ** - Cast containing renal tubular epithelial cells, *** - Cast containing monohydrate calcium oxalate crystals.**

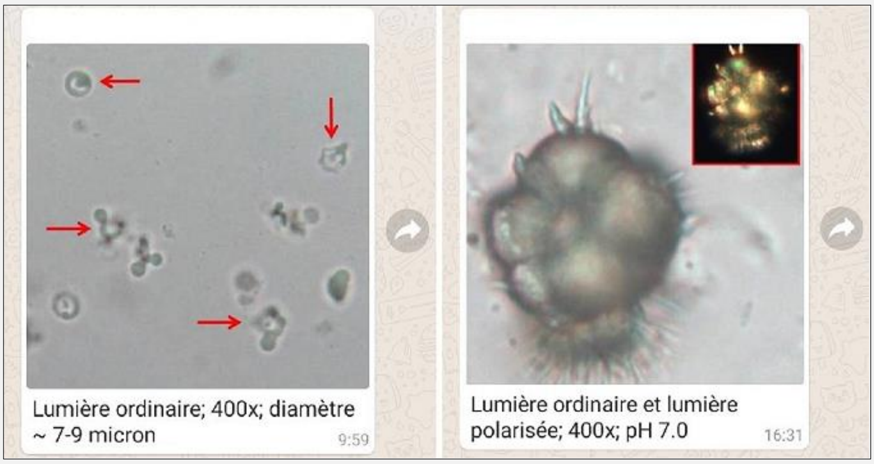


**Figure 1. Images as received via WhatsApp by participants on their smartphones.**

**Left. Exercise of July 17th, 2017: acanthocytes, indicated by arrows (label in English: “Bright field microscopy, 400x, diameter ~7 - 9 µm”). Right. Exercise of May 8th, 2018: ammonium biurate crystal (label in English: “Bright field and polarized light, 400x, pH 7.0”). The number at the bottom right of each image indicates the hour in which the image was sent to participants.**

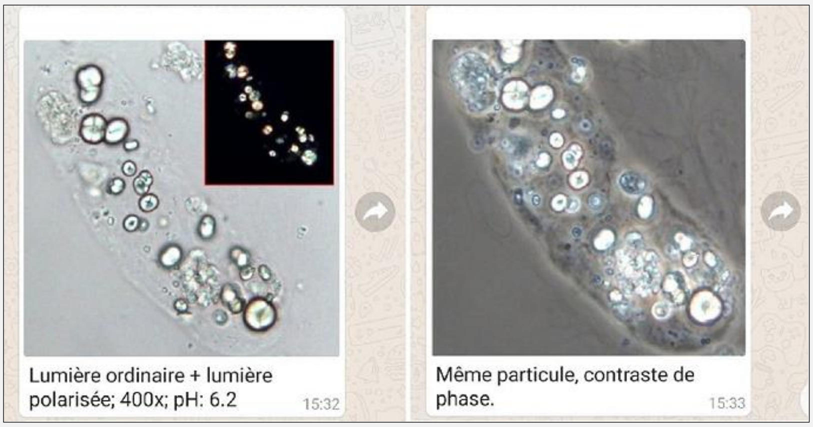


**Figure 2. Images as received via WhatsApp by participants on their smartphones.**

**Left. Exercise of September 3rd, 2018: a crystalline cast containing monohydrate calcium oxalate crystals (label in English: "Bright field and polarized light, 400x, pH 6.2"). Right. The "supplementary image" (label in English: "The same particle, phase contrast microscopy") sent by S.Z. showing the same element as seen with phase contrast microscopy. The number at the bottom right of each image indicates the hour in which the image was sent to participants.**


**Figure 3. Image as received via WhatsApp by participants on their smartphones.**

**Exercise of January 15th, 2018: waxy cast ((label in English: "Bright field microscopy, 400x). Under the image, the 3 clinical associations proposed (label in English: "Clinical meaning: 1. Mild renal disease; 2. Hematuria; 3. Severe renal disease"), this last association being the correct one. The numbers at the bottom right of the image indicate the hour in which they were sent to participants.**

Despite this major limitation, the program reported in this paper shows some interesting points.

The participation rate varied greatly throughout the exercises, however, with an increase in 2018 compared to 2017 (77.0% ± 16.5% vs. 56.0% ± 23.0%). This may suggest an increased interest in the program.

The first identification of the elements showed that basic and locally common elements such as leukocytes, squamous epithelial cells, uric acid, and triple phosphate crystals, and eggs of *Schistosoma haematobium* achieved a 100% rate of correct identification, while for other elements, such as deep transitional epithelial cells, cholesterol crystals, epithelial cast, calcium phosphate plate, and ammonium biurate crystals, the correct rate

was < 50.0%. This demonstrates that several clinically relevant elements are often unrecognized in clinical laboratories, a fact which has been observed also in developed countries [18].
The identification of elements presented twice showed that 8 elements out of 18 obtained a 100% rate of correct answers both at first and at second presentations. Other 5 elements, all of which were clinically relevant (dysmorphic erythrocytes, renal tubular epithelial cells, deep transitional epithelial cells, lipid droplets, waxy casts) showed an increase in correct identification rate when they were resubmitted, while 4 other elements (superficial transitional epithelial cells, erythrocyte casts, uric acid, and monohydrate calcium oxalate crystals) showed a noticeable decrease. These results when associated with those regarding the first identification indicate that the continuation of our educational program is mandatory.
The analysis of clinical association answers demonstrates a 90.0% to 100% correct answer rate for 11 elements out of 17, and a large variability (0% to 85.7%) for the other 6 elements, the worst result being for ammonium biurate crystals, which are both very rare and as yet do not have clear clinical significance [1-3].

## CONCLUSION

The present paper on a small but innovative EQA program on U-sed demonstrates that there is an urgent need for such educational programs in laboratory medicine in developing countries of sub-Saharan Africa; these programs are today feasible because of easily available and inexpensive smartphone applications.

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The authors declare under their responsibility that no personal interests are connected to the present article. No conflicts of interests for any author.

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